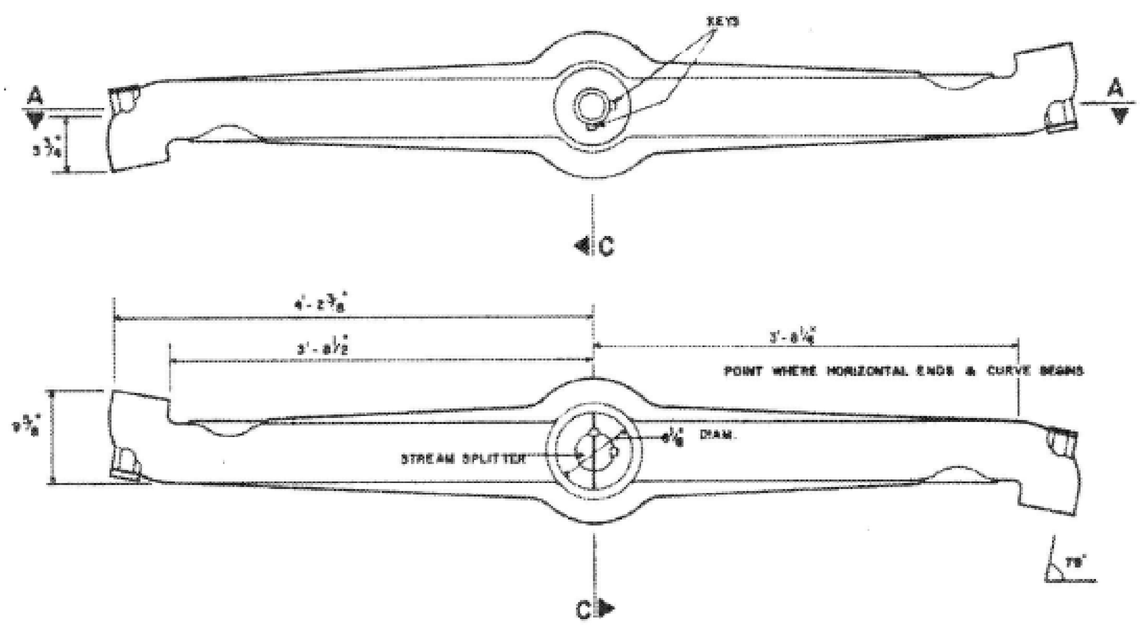
H A C I E N D A   B U E N A   V I S T A

BARKER'S HYDRAULIC TURBINE

1851



A NATIONAL HISTORIC
MECHANICAL ENGINEERING LANDMARK

PONCE, PUERTO RICO
July 16, 1994

The American Society of Mechanical Engineers
The Conservation Trust of Puerto Rico

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK

DESIGNATION CEREMONY
PROGRAM

Master of Ceremonies

CARLOS R. GARRETT

Welcome and Introduction of Honored Guests

FRANCISCO JAVIER BLANCO, Executive Director
The Conservation Trust of Puerto Rico

IGNAZIO J. D'AGATI, PE, Vice President Region II
The American Society of Mechanical Engineers

SUZANNE TOMASINI, Chairwoman, Puerto Rico Section
The American Society of Mechanical Engineers

Welcoming Remarks

MIGUEL MUÑOZ, Under Secretary of Agriculture
The Commonwealth of Puerto Rico

ASME Landmark Program

ROBERT B. GAITHER
ASME History & Heritage Committee

History of Hacienda Buena Vista

GUILLERMO BARALT

Presentation of Plaque

ROBERT B. GAITHER
Past President ASME (100th)

Acceptance of Plaque and Closing Remarks

THE HON. LUIS GUINOT, Esq., Chairman
Board of Trustees
The Conservation Trust of Puerto Rico

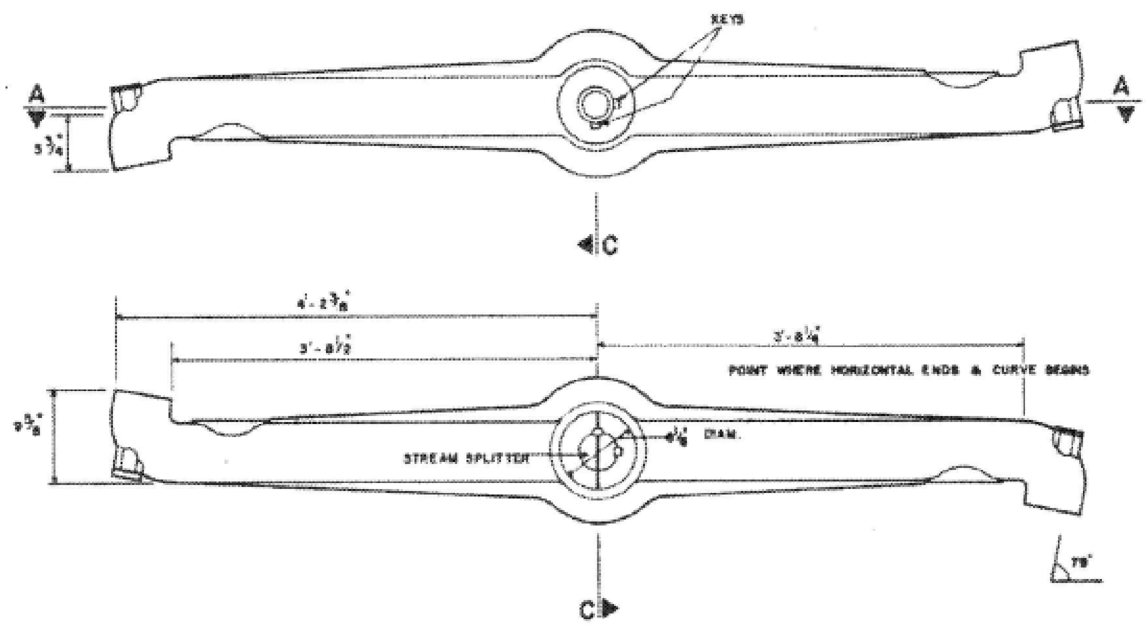
Tour of Site

Saturday, July 16, 1994, at 3:00 P.M.
Hacienda Buena Vista, Ponce, Puerto Rico

HACIENDA BUENA VISTA

BARKER'S HYDRAULIC TURBINE

1851



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CONTENTS

HACIENDA BUENA VISTA

01. THE HYDRAULIC TURBINE

01.01. GENERAL

The Barker's or Scotch Water Wheel at Hacienda Buena Vista

The field of Industrial Archaeology is a relatively new discipline, less than thirty years old in this country and only somewhat older in England, the land of its origin. This is due in part to the fact that historians have traditionally overlooked industrial artifacts in favor of domestic antiques, works of art and architecture as study objects; while sociologists have tended to view these latter as primary source material for their studies of cultural history. However, history is not all a chronology of presidents, kings, and wars. Technological advances have had (and continue to have) extremely pervasive impacts on the shaping of society as well as the physical landscape; and one can but wonder why technological history has been of interest only to a few engineers, scientists, and collectors. Writers have pointed out that we know more about the history of ancient Rome than we know about, for instance, the many small lumber companies with logging railroads in the southeastern Appalachian mountains from 1870-1930; although the impacts these had on the great virgin forests that once covered the area, and the reshaping of the land, remain. Happily, this situation is now changing, though recognition of the value of industrial history, its sites and artifacts, arrived late; Henry Ford, collecting industrial artifacts for the Henry Ford Museum and Greenfield Village, was active in the 1920-35 era--the 'Golden Age' of artifact field collecting and the beginning of the end of the electromechanical age.

Ford, and a few other major museums like the Smithsonian Institution, private collectors and individual enthusiasts are responsible for a majority of technological artifact preservation prior to 1970. We are grateful today for their efforts, without which a great number of artifacts would have been scrapped. But collectors focus on specific types of items, making their selections on pragmatic criteria such as esthetics, size, utility, and cost. Hence certain artifacts--including such items as small steam and oil engines, scientific and technical instruments, woodworking machines, small machine tools, old telephones, and antique automobiles--are collected and preserved. Water turbines provided as great a total horsepower to do the world's work, even in the age of steam; however because they are difficult of access, large and cumbersome, not as aesthetically appealing, and require a water power site to be able to operate, collectors have virtually ignored them, and continue to do so today. Therefore, water turbines in preservation are unfortunately few by comparison with other prime movers. Even if they were common, however, the water turbine that was discovered in the corn mill at Hacienda Buena Vista in 1978 would be no less unique.

The land that forms Hacienda Buena Vista was acquired by Don Salvador de Vives, a Spanish émigré from Venezuela, in the 1830s. In the 1840s, the Vives family established the hacienda as a flour mill, and obtained permission from the Spanish colonial government to use the waters of the Canas River, which traversed the 500-acre farm, for irrigation purposes. The family also received authorization to install, on the river banks, a machine that was operated by a reaction turbine and placed deep in the wheel pit of the corn mill. Eventually the family turned to coffee production, expanded its hydraulic system, acquired more machinery, and became prosperous during the international coffee boom of the 19th century. Several decades into the 20th century the hacienda was sorely afflicted by the fall of coffee prices, compounded by Puerto Rico's agricultural crisis. In 1950 the Puerto Rican government expropriated all but 84 acres of the Vives land, diverting its water and energy resources to build a dam. When the skilled labor force left the farm for better-paying jobs in the city, the plantation fell into near-ruin and so remained until the Conservation Trust of Puerto Rico acquired the historic site.

The interesting hydraulic system and the variety of Victorian machinery at Hacienda Vives, while offering much for historians of technology in its own right, serves also as an important backdrop for the Hacienda's unique water turbine, located in the wheel pit of the corn mill. No other extant example of such a water wheel is known; none are described in current surveys of mills and hydraulic machinery, despite an extensive and growing literature on the subject, and the antiquarian texts on hydraulics only treat of such a wheel in theoretical and philosophical terms, failing to describe any installations, manufacturing details or operational results.

A brief review of hydraulic prime movers may help to put the Vives turbine in proper historical perspective. Those that produce rotary motion (not including pumps, hydraulic rams, etc.,) can be divided into three general categories:

(1) **gravity water wheels,** which operate principally by the weight of water;
(2) **reaction** turbines, which operate full of water, immersed or “flooded”, and
(3) **impulse** turbines; best known to the layman as “Pelton” wheels (after the major manufacturer of these and the primary inventor, Lester Allen Pelton) which are driven by the impulse of jets of water on a wheel rotating in air.

The varieties of gravity wheels--overshot, breast, Poncelot, etc.--are the oldest of the trilogy. Their origins are lost in antiquity; they were known to the ancient Romans, and pre-1850 treatises on hydraulics treat of these as the sole type of water prime mover, with the exception of the Barker's Mill which is widely noted in works on hydraulics but as a philosophical toy rather than a prime mover producing useful power.

Engineers among our readers will note that our three categories above are intended for quick identification of basic water wheel types for the layman. (Most mid-nineteenth and twentieth-century texts on hydraulics and hydraulic motors also treat water prime movers in these same three categories.) Most extant hydromachinery dates back only to the beginning of the 19th century. The very few surviving mills of earlier dates are powered by gravity water wheels, or their wheels were replaced by turbines in the 19th and early 20th centuries.

The American reaction turbine, our 2nd category, is really an invention of the 19th century; and partially the result of improvements in the abilities to work metals. The turbine's ancestry can, if one does not split hairs over the terminology, also be traced back to the so-called "flutter" or "tub" wheels of ancient times, made of wood. Like the gravity wheels, these are the products of local craftsmen, and operate on both the impulse and reaction principles. Their evolutionary path split in the 19th century, leading to the pure impulse or Pelton wheels, driven by jets of water impinging against shaped buckets, and also to the reaction turbines, placed in an unbroken column of water. The first metal water wheel that could be given the name "turbine" was the so-called Barker's Mill-and the sole known extant example of this pioneer and historically important machine remains at Hacienda Vives.

Dr. Barker's 'Mill' was invented at the close of the 17th century, and remained a laboratory curiosity for the next 100 years. It was described by many writers on hydraulics, beginning with Desagulier's "Experimental Philosophy" (Volume 2, page 460) in 1743. Some 18th and 19th century writers credit a certain Parent with the original idea of the reaction turbine, and claim that Dr. Barker demonstrated it by building a working model. Dr. Barker's mill was, however, the first turbine to operate strictly on the principle of pure reaction.

In 1775 M. Mathon de La Cour proposed in his "Journal de Physique" an improvement to Dr. Barker's mill. Barker's mill consists of an upright column or tube with two crossarms at the lower end, like an inverted letter T. One side of each of these crossarms was perforated so a jet of water could issue and spin the entire T, like the common lawn sprinkler of today. La Cour proposed to bring the water to the runner from below--a significant improvement, as the rotating portion (the runner) was greatly reduced in size and weight; the entire column of water and its supporting tube no longer had to rotate--just the arms carrying the jets. Furthermore, the water pressing upward from below helped to lift or at least relieve some of the weight of the drive shaft, millstones (or whatever machinery was employed) thus reducing friction on the thrust bearing. Count Rumsey claimed La Cour's improvements as his own in 1795. La Cour claimed to have seen one such wheel operating on his design in service. However, texts of the period are virtually silent about actual operational examples of a Cour's improved Barker's Mill.

James Whitelaw, with James Stirrat, patented an improved version of Barker's mill in 1841 in England and 1843 in America. Their wheel became known as the "Scotch" turbine, and is often treated in texts on hydraulics as the first true metal turbine water wheel. Whitelaw patented La Cour's improvement of the bottom-feeding of the supply water, and also added spiral curved arms decreasing in cross-section from wheel opening to jet. His 1843 American patent (#3,153) claims the proportioning of these arms as his patentable improvement. The Scotch turbine was manufactured in Europe and America by a number of firms from the 1840's until the early 1870's by which time the great variety of turbines introduced by Howd, Boyden, Fourneyron, Francis, and others had rendered it obsolete.

The rarity of extant examples of such machines may be gathered from the fact that despite extensive searches, only three Scotch turbines are known to exist in America today.

It is unlikely that additional finds will be made, since most of those were removed and replaced with more efficient turbines in the latter half of the 19th century. However--until the discovery was made at Hacienda Vives-- **no turbines of pre-Scotch type were known to exist!**

The Vives turbine originally posed more questions than it answered; for it carries no builder's plate or identification, and it exhibits no specific mechanical features that trace it even to a country of origin, much less a manufacturer. It could be assumed to be of British or Scottish, American, or local (Puerto Rican) manufacture, with some support for all claimants. In construction it is a sophisticated machine; well-executed in cast iron and fitted with cleanout ports covered by removable metal plates, and most remarkable of all, jet nozzles of brass fitted with pear-shaped nozzle valves, adjustable via screw threads, to balance the thrust of the two arms of the turbine runner, and to adjust the machine to varying quantities of water. These are the direct ancestors of the needle-regulating nozzles patented by Abner Doble, as one of his improvements for the Pelton impulse wheel--over a half-century later! The discovery of the Vives turbine was followed by nearly a decade during which much research was undertaken and much speculation arose as to its origin. All was fruitless, until Dr. Guillermo Baralt, Historian for the Conservation Trust, was able to acquire historic papers and records from the Vives family, records that miraculously had survived well over a century--and in one stroke solved the mystery! The Barker's turbine was built by the famous historic firm of West Point Foundry, Cold Spring, New York; it was shipped in December of 1853 to Buena Vista!

Interestingly, the invoice Dr. Baralt found in the Vives records refers to the turbine as a *'Scotch Mortar Wheel.'* It continues: *'--to explain this modification of Mr. Whitelaw's turbine, lately introduced, and now used by him for falls of considerable height.'* So the Vives 'Barker's mill' actually followed the original Whitelaw Scotch turbine, as a modification Whitelaw evolved for use with higher heads of water. The Vives turbine, then, is two things: (1) the "missing link" in the evolution of turbines; the ancestor of the Scotch turbine as commonly depicted in books on hydraulic turbine history, and (2) a later deliberate reversion to the Barker design, (with modifications) for specific applications, by the inventor of the Scotch turbine. Thus, the ancestry of the reaction turbine may be summed up as:

- Dr. Barker's Mill, late 17th century; first written record 1743
- La Cour's improvement, 1775
- Rumsey claims la Cour's improvement, 1795
- Whitelaw's improvement, 1841-43 - the Scotch turbine.
- Whitelaw's adaptation of the Barker's mill for higher heads - the Vives turbine, 1853.

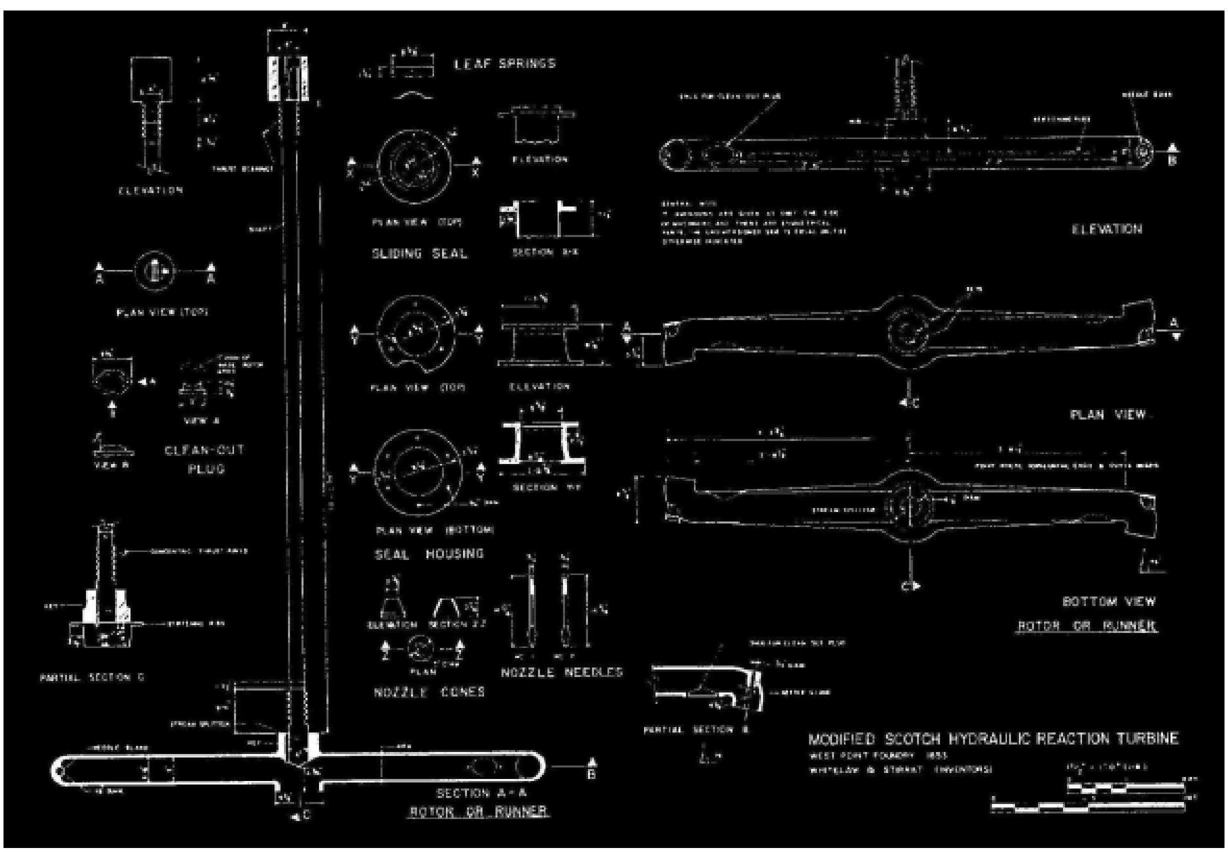
Hopefully this will explain the great historical importance of this unique surviving example of a pioneer turbine. The Barker's or La Cour's centrifugal water wheel--to give it its own nomenclature, proposed two centuries ago--or the Scotch Mortar Wheel, as its builder called it--at Hacienda Vives surpasses in historical importance most mechanical artifacts better known to the historian of technology. Posterity has more than a single example of Newcomen's and Watt's pioneer steam engines; several Otto and Langen oil engines exist; but even the International Symposiums on Molinology have failed to discover or record any more extant examples of the Barker's wheel, in any incarnation; i.e. by other builders, or Whitelaw's modification. As a part of the team that was entrusted with the restoration of this unique machine, the writer is sobered to reflect that on the day the restored turbine was first tested under water power, in 1987,134 years had passed since it was shipped from New York, and 4 generations had gone by since any living person had seen one of these Scotch-type turbines at work.

01.02. HYDRAULICS

On February 1992 an estimate of the power generated by the hydraulic turbine at Hacienda Buena Vista was made using the well known equation:

$$P\,(hp) = \frac{T * N}{550} * e\,.$$

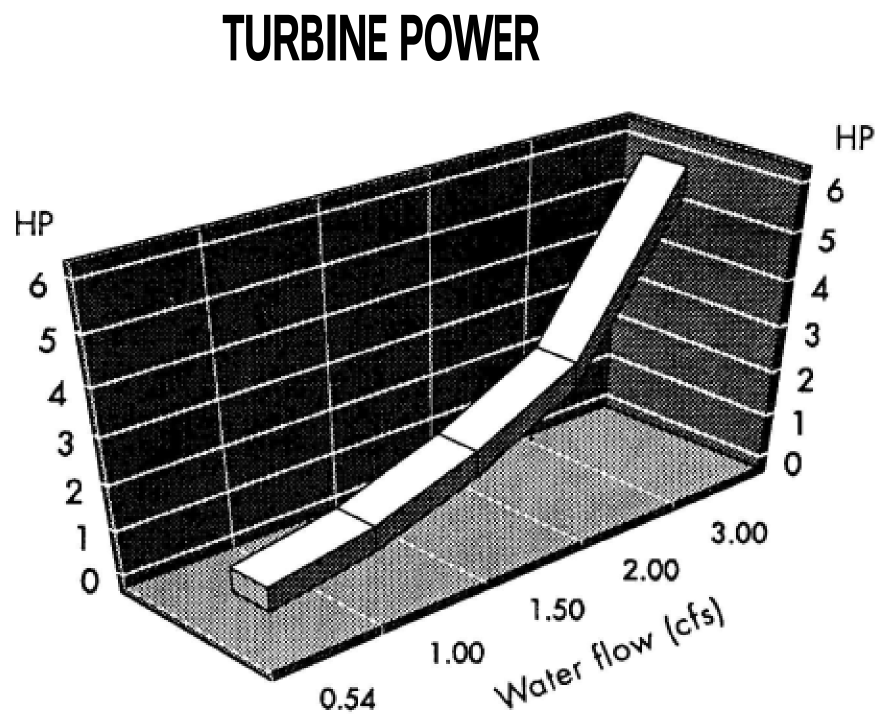
Figure 1 shows the turbine runner and the dimensions required for the calculations.



Of considerable concern was the efficiency value to be used. Since this value is a function of the nozzle and water jet velocities (and therefore the turbine angular velocity and the head of the water in the supply stand pipe) a fixed average value of 0.6 was selected for calculation purposes.

In order to perform this estimate the mass flow of the water entering the turbine and the angular velocity of the runner had to be measured. A water flow of 0.54 cubic feet per second was obtained (see below) for the no-load, steady state operation. For this condition an average angular velocity of 22 revolutions per minute was measured.

Power calculations were performed for water flow values of 0.54, 1.0, 1.5, 2.0 and 3.0 cubic feet per second. For the no-load condition (0.54 cfs) the value obtained was 0.12 hp. This value appears to be somewhat low. It should be pointed out, though, that at no-load the turbine, gears and corn mill can be easily turned by hand. The results of all calculations are shown on the graph, Figure 2. This figure clearly shows the exponential nature of the power curve.

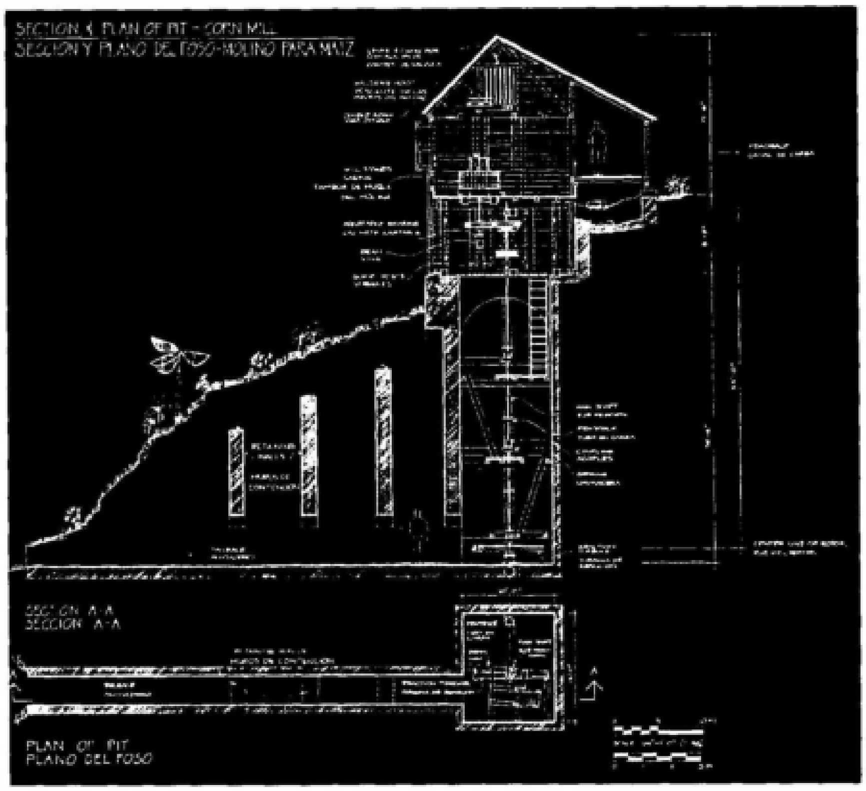


These calculations provide only a first approximation of the true power output of the turbine and were intended as a guide for the design of a prony brake to measure the actual power at different loads. A proposal to perform this work has been submitted to the Conservation Trust.

In the same month a 90-degree weir was installed immediately before the settling tank in the water channel leading to the turbine supply pipe. With the gate at the head of the water channel fully open a water flow of 0.54 cubic feet per second was measured. This was the value used for the power calculations even though there was a minor leakage through a side gate just before the turbine water supply stand pipe.

01.03. ASSOCIATED EQUIPMENT

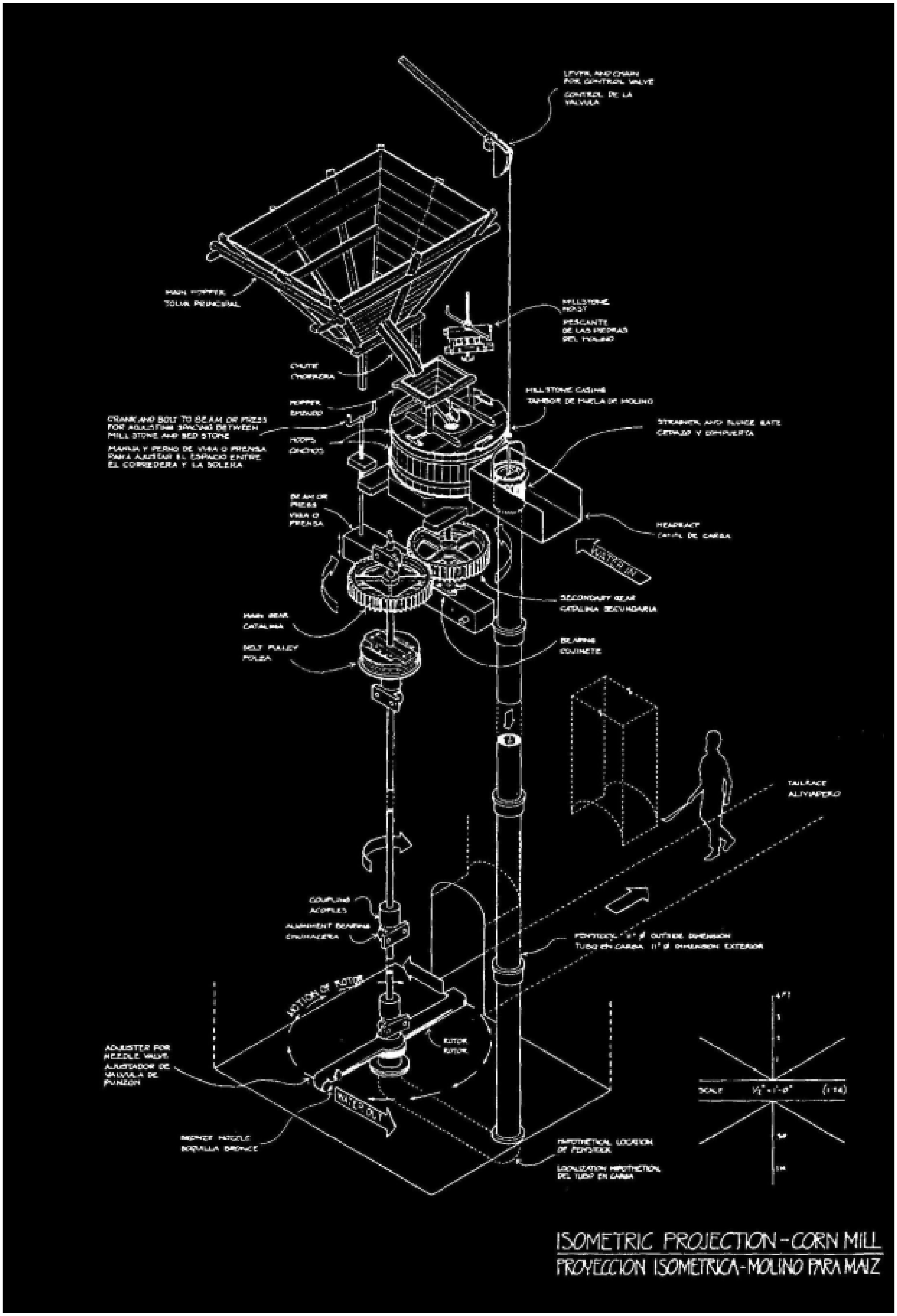
Power is transmitted upward by a four inch diameter steel shaft turning a 50 tooth spur gear which turns another spur gear of identical dimensions and characteristics. This second one drives the vertical shaft which provides support and torque to the rotating grindstone at the same rotational speed as the main shaft. See Figure 3 and 4.



This arrangement of gears turning at the same speed is dictated by the need of clearance adjustment between the two grindstones. The lower end of the rotating grindstone shaft rests on a journal bearing cushion which in turn is supported by a horizontal beam. This beam is pivoted at one end and held at the other by a vertical threaded shaft. The whole structure moves up or down as the nut at the upper end is turned. This nut is adjusted by the mill operator to obtain the desired flour fineness.

A drive pulley is attached to the vertical shaft to power an eccentric mechanism which shakes the flour discharge spout in order to assure a smooth and continuous flow of flour from the mill assembly to the bagging machine.

The water supply stand pipe is provided with a control valve which is operated by a lever adjacent to the grindstones. After the gates upstream in the water channel have been properly set the operator need only open the control valve to start the mill. This valve must be adjusted according to the load in order to maintain a constant and proper speed.


LEVER AND CHAIN FOR CONTROL VALVE
CONTROL DE LA VALVULA
MAIN HOPPER
TOLVA PRINCIPAL
MILLSTONE HOIST
PESCANTE DE LAS PIEDRAS DEL MOLINO
CHUTE
CHORRERA
HOPPER
EMBUDO
MILL STONE CASING
TAMBOR DE MUELA DE MOLINO
CRANK AND BOLT TO BEAM OR PRESS FOR ADJUSTING SPACING BETWEEN MILL STONE AND BED STONE
MANIJA Y PERNO DE VIGA O PRENSA PARA AJUSTAR EL ESPACIO ENTRE EL CORREDERA Y LA SOLERA
HOOPS
STRAINER AND SLUICE GATE
CEDAZO Y COMPUERTA
BEAM OR PRESS
VIGA O PRENSA
HEADRACE
CANAL DE CARGA
WATER IN
SECONDARY GEAR
CATALINA SECUNDARIA
MAIN GEAR
CATALINA
BELT PULLEY
POLEA
BEARING
COJINETE
TAILRACE
COUPLING
ACOPLES
ALIGNMENT BEARING
CHUMACERA
PENSTOCK 11" Ø OUTSIDE DIMENSION
TUBO EN CARGA 11" Ø DIMENSION EXTERIOR
MOTION OF ROTOR
ROTOR
ROTOR
ADJUSTER FOR NEEDLE VALVE
AJUSTADOR DE VALVULA DE PUNZON
WATER OUT
BRONZE NOZZLE
BOQUILLA BRONCE
HYPOTHETICAL LOCATION OF PENSTOCK
SCALE
(1:24)
ISOMETRIC PROJECTION - CORN MILL
PROYECCION ISOMETRICA - MOLINO PARA MAIZ

01.04. MAINTENANCE

A computerized maintenance program was installed at the Buena Vista to provide timely maintenance instructions and procedures for the machinery. These include all adjustments, lubrication and general upkeep procedures for both the turbine and the hydraulic wheel. Subsequently the program was enlarged to include all periodic agricultural and physical plant maintenance tasks at the Hacienda. The maintenance program was kindly ceded to the Conservation Trust by Ing. Julián Londoño of Software Technologies.

02. THE HISTORY AND HERITAGE PROGRAM OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The ASME History and Heritage Recognition Program began in September 1971. To implement and achieve its goals, ASME formed a History and Heritage Committee, composed of mechanical engineers, historians of technology, and the Curator Emeritus of Mechanical and Civil Engineering at the Smithsonian Institution. The Committee provides a public service by examining, noting, recording, and acknowledging mechanical engineering achievements of particular significance. The History and Heritage Committee is part of the ASME Council on Public Affairs and Board on Public Information.

Since the ASME History and Heritage Program began, 163 Historic Mechanical Engineering Landmarks, 6 Mechanical Engineering Heritage Sites, and 6 Mechanical Engineering Heritage Collections have been recognized. Each reflects its influence on society, either in its immediate locale, nationwide, or throughout the world.

An ASME landmark represents a progressive step in the evolution of mechanical engineering. Site designations note an event or development of clear historical importance to mechanical engineers. Collections mark the contributions of a number of objects with special significance to the historical development of mechanical engineering.

The ASME Historic Mechanical Engineering Recognition Program illuminates our technological heritage and serves to encourage the preservation of the physical remains of historically important works. It provides an annotated roster for engineers, students, educators, historians, and travelers, and helps establish persistent reminders of where we have been and where we are going along the divergent paths of discovery.

03. THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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04. THE WEST POINT FOUNDRY ASSOCIATION

The West Point Foundry Association was established at Cold Spring, New York, by Gouverneur Kemble who, with others, were incorporated under that name. The first works was erected in 1817, and was designed for the casting and boring of cannon for the United States Navy and Army with the assurance of support and encouragement from the government.

Until 1851 the Association was operated as a private establishment by one of the proprietors who leased the shares of others. At that time, R.P. Parrott, who had become connected with the works in 1836, leased the shares of Kemble and the other proprietors and became the sole lessee, assisted in the management by Gouverneur Paulding. Parrott was a graduate of the U.S. Military Academy at West Point, and a captain in the Ordnance Department of the United States.

A problem arose when the cannon were not ordered in such quantities or with such regularity as to give steady employment. Other work necessarily was sought, and the West Point Foundry turned gradually to the manufacture of general castings, steam engines and boilers, and other heavy equipment, with a forging department capable of making the heaviest pieces.

Among the products of the Foundry were the engines of the U.S. Naval steamers “Missouri” and “Merrimac,” the Cornish pumping engine for the Jersey City Waterworks at Belleville, and the pumping engine of the dry dock at the Brooklyn Navy Yard. Sugar-mill machinery, steam engines, hydraulic presses, and blowing engines, all of the largest size, were turned out in quantity A wide range of more routine products also was produced such as cast-iron water pipe, wrought-iron shafting, and a line of general castings and forgings. Much of this machinery and other equipment was exported and was highly reputed in comparison with that of other countries. The establishment that originally was a cannon foundry of moderate size costing about $90,000, grew to one of immense capacity, employing at times as many as 1,000 men.

The location of the West Point Foundry at Cold Spring was determined by two considerations: one, the U.S. Government’s desire at the time that a gun foundry not be too near the coast; and the other, the availability of water power from a stream entering the Hudson River at Cold Spring.

The name West Point Foundry arises from the fact that at the time Cold Spring was only a small landing place of three houses and West Point was the only well-known place in the vicinity, although on the opposite side of the Hudson.

The West Point Foundry came to prominence in connection with the manufacture of rifled cannon. Numerous experiments with its manufacture had been made in Europe, and in 1858 and 1859 many tests were made in the United States, chiefly with guns ordered by the Ordnance Department according to plans and specifications brought forward by different inventors. The cannon were, as usual, of cast iron, bored somewhat smaller than normal, and rifled. A projectile frequently used at the time was that of Dr. J.B. Read, of Alabama, in which a cup or flange of wrought iron was cast in the projectile. It was expected that the force of the explosion would cause the rim of the cup to take the grooves. Other forms of projectile were later devised, based on an improvement by Parrott of swaging out the cup partially to the form of the grooves, thus facilitating the "taking" of them at firing.

In 1860, Parrott introduced the first of the guns now known as "Parrott Guns." One peculiarity of the Parrott Gun was a band or reinforcement of wrought iron at the breach end, made by coiling a bar of iron upon a mandril, and then welding this coil into a cylinder which was afterward bored, turned, and shrunk upon the gun.

The Parrott gun was refined again and again, becoming the main armament used both by the Army and the Navy during the American Civil War. It was of two types: that suitable for operation in mobile conflict; and a heavier gun for stage purposes. They contributed largely to the victories of the Union forces at Fort Macon and Fort Pulaski. At the bombardment of Fort Sumter from Morris Island, as well as in the shelling of Charleston, Parrott Guns were used almost exclusively.

Among the many accomplishments of the West Point Foundry Association, was building the first locomotive manufactured in America for actual service on a railroad: *The Best Friend of Charleston.* This locomotive was contracted for by E.L. Miller, of Charleston.

According to a letter written in 1859 by David Matthews, foreman of the fitting department of the Foundry:

> "*The Best Friend* was a four-wheel engine, all four wheels drivers. Two inclined cylinders at an angle, working down on a double crank inside of the frame, with the wheels outside of the frame, each wheel connecting together inside, with outside rods. The wheels were iron hub, wooden spokes and felloes, with iron tire and iron web and pins in the wheels to connect the outside rod to.
>
> "The boiler was a vertical one, in form of an old-fashioned porter bottle, the furnace at the bottom surrounded with water, and all filled inside full of what we called teats, running out from the sides and top, with alternate stays to support the crown of the furnace; the smoke and gas passing out through the sides at several points, into an outside jackets; which had the chimney on it. The boiler sat on a frame upon four wheels, with the connecting-rods running by it to come into the crank-shaft. The cylinders were about six inches bore and sixteen inches stroke. Wheels about 4 1/2 feet in diameter. The whole machine weighted about 4 1/2 tons. It was shipped to Charleston, South Carolina, for the Charleston and Hamburg Railroad, in the fall of 1830, and was put upon that road during the winter.

> "It was the first locomotive built in America, was exhibited at our shop under steam for some time, and visited by many. She was shipped to Charleston on board of the ship *Niagara*, in October 1830." (*The History of the First Locomotive in America,* William H. Brown, D. Appleton and Co., N.Y., 1874, pages 140-41.)

The West Point Foundry was also responsible for building the second American locomotive, aptly called the *West Point,* for the South Carolina Canal & Railroad Co., in 1831. According to Matthews, this locomotive had the same size engine, frame, wheels, and cranks, as the *Best Friend,* but had a horizontal boiler with tubes two and a half inches in diameter and about six feet long. also in 1831 the foundry built the *DeWitt Clinton,* New York State's first steam locomotive. IN 1832, West Point Foundry built a locomotive called *The Experiment,* which set a unofficial world speed record of 80 mph.

During the Panic of 1873, the West Point Foundry ran into trouble. A change in administration after Parrott's death affected the contracts. Moreover, their source of material, the iron-ore deposits near the plant, could not compete with the rich deposits found in the West. By 1886, the population of Cold Spring started declining, and in 1911 the Foundry was closed, after almost one hundred years of successful operation.

Although very frustrating for historians and researchers, it is interesting to note that being in the armament business, the West Point Foundry had a systematic method for disposing its records. Every four years a huge bonfire was lit in its yard for burning all sensitive material such as plans, specifications, etc. The only available evidence of the firm's work is in manufacturers' catalogs and technical books of the time.

05. THE PUERTO RICO CONSERVATION TRUST

BOARD OF TRUSTEES

CONSERVATION ADVISORY COUNCIL

THE PUERTO RICO CONSERVATION TRUST

On December 24, 1968, the Governor of Puerto Rico, the U.S. Secretary of the Interior, and the Administrator of the Economic Development Administration agreed to create a fund in trust to preserve and enhance the beauty and natural resources of Puerto Rico. The institution was endowed through contributions from petroleum and petrochemical companies operating on the Island. The trust was constituted by deed on January 23, 1970, as a private charitable institution. The sole beneficiary of the Trust is The People of Puerto Rico.

The Conservation Trust of Puerto Rico has acquired land of extraordinary ecological and historical value. These properties exemplify the Island's rich array of topographical and physical features: the escarpment of the central mountain range (La Cordillera Central), rolling hills and lagoons, mangroves and dry forests, capes and promontories, green valleys and steep karsthills, rocky and sandy beaches, a deep winding canyon and other magnificent natural features.

Historic buildings, mills, and machinery on many of these properties document Puerto Rico's social and economic history. Archaeological sites contain evidence of the Island past stretching back 2,000 years before Columbus.

The Trust rescued several of these properties from commercial, industrial; or touristic development that would have destroyed some of the most beautiful and ecologically important features of the Island. One of the sites is protected by a scenic easement and restrictive covenants,- the first time in Puerto Rico's history that these provisions have been used for land preservation.

06. HISTORIC AMERICAN ENGINEERING RECORD

The Historic American Engineering Record (HAER) was established in 1969 by the National Parks Service in cooperation with the Library of Congress and the American Society of Civil Engineers. The ASME now is a party to the enabling agreement. HAER documents engineering landmarks through photography and drawings.

Since its inception, HAER has compiled considerable documentation of examples of civil engineering genius, historical engineering works of the mechanical and electrical engineering professions, and other engineering feats around the country. HAER records a complete summary of engineering technology by surveying significant examples of engineering solutions which demonstrate the accomplishments of all the branches of the profession.

HAER has initiated an active campaign of documenting the country's rapidly diminishing heritage of historical significant engineering works. The work is carried on largely through contracts with universities and cooperative projects with local governmental and preservation organizations. Recording is done primarily during the summer by field teams recruited from the nation's leading universities. HAER is a long range program for assembling archives of significant engineering works in the United States.

07. ACKNOWLEDGEMENTS

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Besides the officers of the PRCT, of ASME National and of ASME Puerto Rico, the following had a great share in said successful operation.

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RICHARD BROWN-CAMPOS, PE
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08. SOURCES OF INFORMATION

Patent: #3,153 to Whitelaw and Stirrat, July 3,1843, for their water wheel called the "Scotch Turbine"

Books

Baralt, Guillermo, *LA BUENA VISTA.* Fideicomiso de Conservación de Puerto Rico. San Juan, 1988.

Church, Irving P., *Hydraulic Motors,* 1905, John Wiley & Sons, NY. 1st edition, pp83-93

Daugherty, Robert L., *Hydraulic Turbines,* 1914, McGraw-Hill Book Co., Inc. NY. p28

Ewbank, Thomas, *A Descriptive and Historical Account of Hydraulic and Other Machines for Raising Water,* 1849, Greeley & McElrath, NY 3rd edition, pub. in 5 sections. p230

Glynn, Joseph, *The Power of Water,* 1853, John Weale, London pp50-55

Lardner, Dionysius, *Treatise on Hydrostatics and Pneumatics,* 1834, 1st American, from 1st London edition; pub. by Nathan Hale, Boston, Mass. pp156-157

09. THE BROCHURE

The text of the material on Hacienda Buena Vista was compiled and edited by Carlos R. Garrett, PE, Chairman of the History and Heritage Committee of the Puerto Rico Section of the American Society of Mechanical Engineers.

Section 01.01.- GENERAL was written by Mr. Robert L. Johnson.

Sections 01.02.- HYDRAULICS, 01.03.- ASSOCIATED EQUIPMENT, and 01.04.-MAINTENANCE were written by Richard Brown, PE

Section 02.- THE WEST POINT FOUNDRY ASSOCIATION is based on material provided by: Tom Rick, Manitou Machine Works, Cold Spring, N.Y.; Robert M. Vogel, Curator Emeritus Division of Mechanical and Civil Engineering, The National Museum of History and Technology, Smithsonian Institution; Robert L. Johnson, Curator and Owner, Whistles In the Woods Museum; the late Benjamin Nistal-Moret; and the The Putnam County Historical Society.

Drawings were prepared by the Historic American Engineering Record team and Richard Brown, PE.